# The Elemental Composition and Characteristics of Indoor Dust in Brisbane Homes after the 2011 Flood

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*Keywords: particle, residential houses, indoor air*

## 1 Introduction

Many Brisbane houses were affected by water inundation as a result of the flooding event which occurred in January 2011. The combination of waterlogged materials and large amounts of silt and organic debris in affected homes gave rise to a situation where exposures to airborne particles and dust could potentially be elevated. However, swift action to remove wet materials can help to reduce moisture and humidity in flooded houses, in an effort to improve indoor air quality in and around flooded areas. In order to gain an understanding of the effect of flooding on the concentration of inorganic elements in indoor dust, field measurements were carried out during 21 March and 3 May, 2011.

## 2 Materials/Methods

In total, 39 houses were selected, 24 which were affected by the flood and 15 which were not. In addition, one flood-affected commercial property (factory) was chosen to serve as a comparison to the residential houses. The houses selected covered a wide range of ages, building materials and styles.

In addition to other measurements, dust samples were collected on a $1m^2$ glass panel, which was placed in each house for one week. The dust on the glass panels was than wiped onto a pre-weighed KimWipe (tissue). The tissue and collected dust were then weighed in the laboratory to determine the mass of the deposited dust, after which the tissue was microwave digested in 15ml of concentrated $HNO_3$ for 15 minutes at 180°C. The diluted digest was analysed by ICP-MS (Inductively Coupled Plasma Mass Spectroscopy) to determine the concentrations of twenty four elements, including: Lead (Pb), Barium (Ba), Beryllium (Be), Calcium (Ca), Sodium (Na), Potassium (K), Magnesium (Mg), Arsenic (As), Aluminium (Al) and transition metals including Iron (Fe), Chromium (Cr), Cadmium (Cd), Cobolt (Co), Nickel (Ni), Mercury (Hg), Titanium (Ti), Vanadium (V), Copper (Cu), Zinc (Zn), Molybdenum (Mo), Strontium (Sr) and Manganese (Mn).

## 3 Results

The inorganic elemental concentration in the dust from each house is shown in Figure 1. Of the 24 elements assessed, 7 (Li, Be, V, Cr, Co, Ni and As) were below the detection limit in all samples.

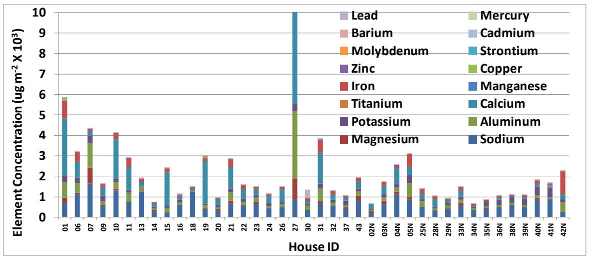


**Figure 1**. Indoor dust element concentrations for each house. Flood-affected House IDs: 01-37, Non-affected House IDs: 02N-42N, House ID 43 is the flood-affected factory office.

From Figure 1, it can be seen the concentration of elements in the dust samples varied considerably for both flooded and non-flooded houses. House 27 shows the highest mass concentration levels of all the elements, which is likely to be the result of renovation works that were being conducted in the house during the sample collection period. As such, House 27 was excluded from further statistical analyses. The variation of total mass concentration for all elements among the remaining houses ranged from 741-5840 µg $m^{-2}$, with an average of 2253 ± 1314 µg $m^{-2}$ for flooded houses and 657-3086 µg $m^{-2}$, with the average of 1463 ± 699 µg $m^{-2}$ for non-flooded houses. Overall, the total mass concentration for flooded houses showed a wider variation than for non-flooded houses.

Figure 2 and Figure 3 show the average elemental concentrations and percentage contribution of the each element to the total elemental concentrations for the two groups of houses, respectively.

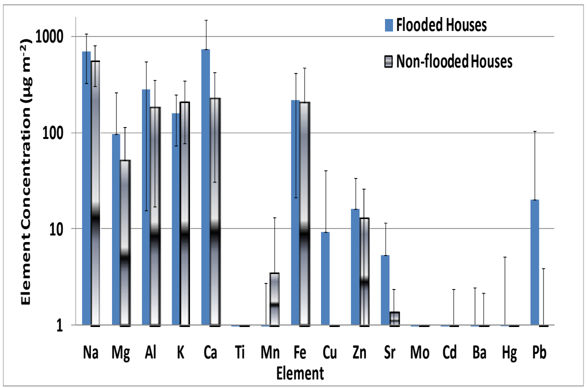


Figure 2. The average elemental concentrations of the two group houses

It can be seen from Figure 2 that the concentrations of Na, Mg, Al, Ca, Cu, Zn, Sr and Pb were higher in flooded houses compared to non-flooded houses. However, statistical analyses indicated that only Ca and Sr concentrations were significantly higher ($p < 0.01$) than those in non-flooded houses. It was also found that the average total concentration of heavy metal (Mn, Fe, Cu, Zn, Cd, Pb) in the flooded houses was higher (18%) ($p < 0.05$) than in the non-flooded houses.

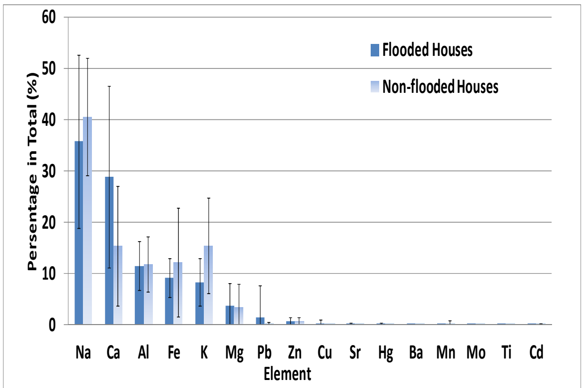


Figure 3. The average percentage contribution of the each element to the total elemental concentrations for the two groups of houses.

From Figure 3, it can be seen that the first 5 elements (Na, Ca, Al, Fe and K) constituted a dominant proportion of the total dust (93.6%) in flooded houses. For non-flooded houses, the 5 dominant elements were Na, Ca, K, Fe and Al (95.3%). Thus, the elemental composition of the two groups of houses was similar.

## 4 Discussion

Robertson et al. (2005) collected and analysed house dust from 12 residential houses in Brisbane. A list of the most abundant elements (%) in this and Robertson's study is given in Table 2. In Robertson's study, Sodium (Na) was not measured and Lead (Pb) was not detected.

**Table 2.** A list of the most relatively abundant elements (%) in this study and Robertson's study (*assuming: Na was about 40%*)

| FH | (%) | NFH | (%) | Robertson* | |
|---|---|---|---|---|---|
| Na | 35.8 | Na | 40.6 | *Na* | *40.0* |
| Ca | 28.9 | K | 15.4 | Ca | 36.1 |
| Al | 11.5 | Ca | 15.4 | Al | 12.0 |
| Fe | 9.14 | Fe | 12.2 | K | 8.22 |
| K | 8.31 | Al | 11.8 | Mg | 2.90 |
| Mg | 3.72 | Mg | 3.44 | Ba | 0.55 |
| Pb | 1.43 | Zn | 0.74 | Sr | 0.09 |
| Zn | 0.70 | Mn | 0.19 | Rb | 0.08 |
| Cu | 0.22 | Pb | 0.12 | Bi | 0.04 |
| Sr | 0.20 | Sr | 0.09 | Li | 0.02 |

FH: flooded house, NFH: non-flooded house. *: To enable comparison between the studies, the percentage values from Robertson's study were calculated based on the assumption that the percentage of Na was 40%, since the corresponding value was around 40% non-flooded houses in a non-flooded area in this study.

A comparison with Robertson's data found that the percentage of Fe, Pb and Zn in both flooded and non-flooded houses were higher than those measured by Robertson's study. This finding implies that the flooding event affected the elemental composition of dust in both flooded and non-flooded houses in the areas inundated by water during the 2011 Brisbane flood.

## 5 Conclusions

These results imply that the 2011 flood contributed to the observed increase in indoor dust levels. There was no significant change in the elemental composition of indoor dust between the flooded and non-flooded houses. However, compared to the normal situation (i.e. in the absence of a flooding event), the elemental composition of indoor dust changed significantly following the flooding event.

## 6 References

Robertson, S., Ayoko, G., Duigu, J. Elemental & PAH compositions of house dust in Brisbane, Australia. In Proceedings: 10th International Conference on Indoor Air Quality and Climate, 1-5: 1536-1540, 2005.